Efforts for a Successful Radiological Contamination Removal Action:

Site 1, Thorium Spill at Indian Head, MD

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Objective

Summarize Considerations for a Removal Action with soils contaminated with LLRW

- Brief description of radioactivity
- Summarize the removal action and history
- Inform RPMs regarding project challenges/ and lessons learned.

Radiological Overview

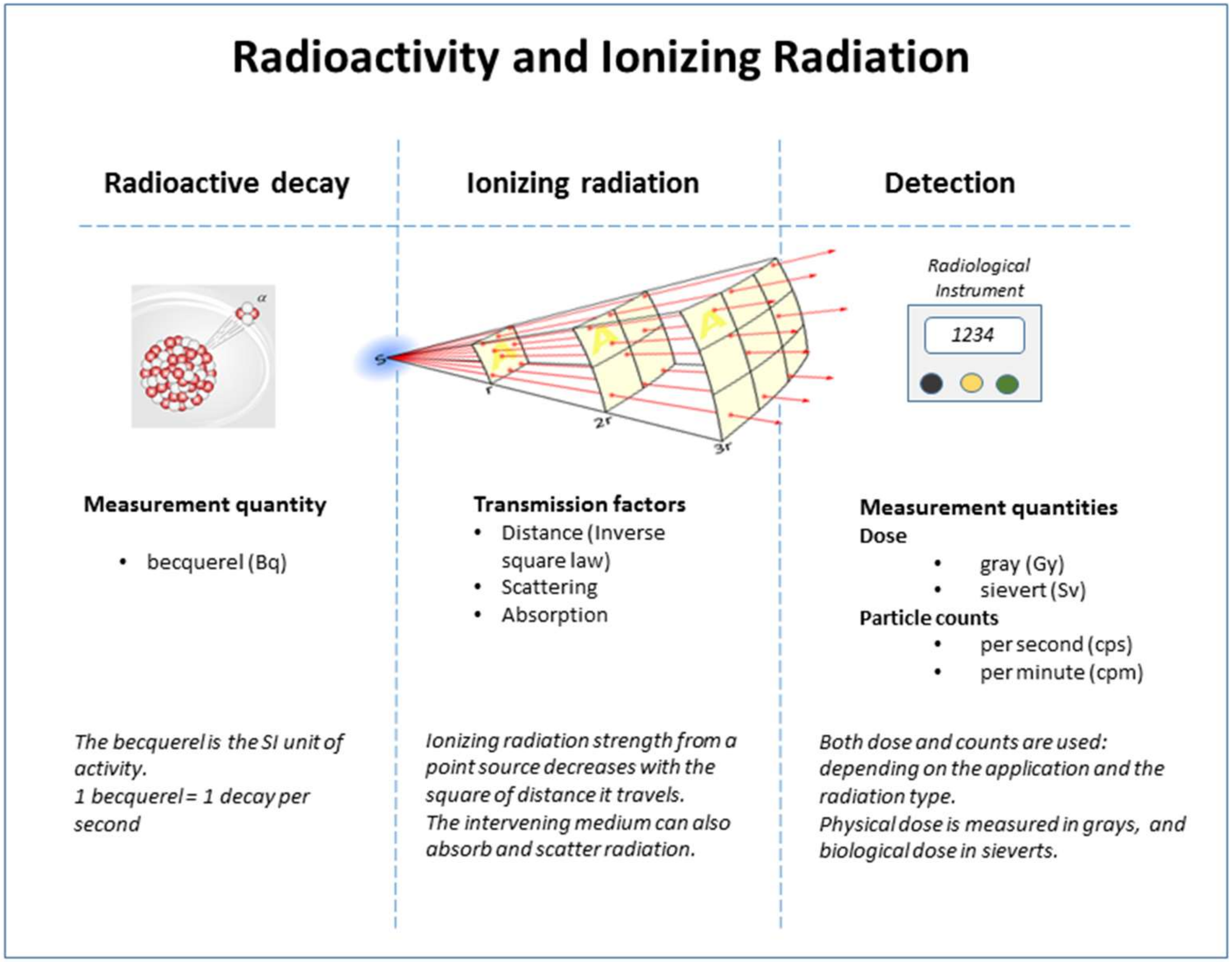


Image from Wikipedia <https://en.wikipedia.org/wiki/Becquerel>

Radionuclides decay, emitting ionizing radiation:

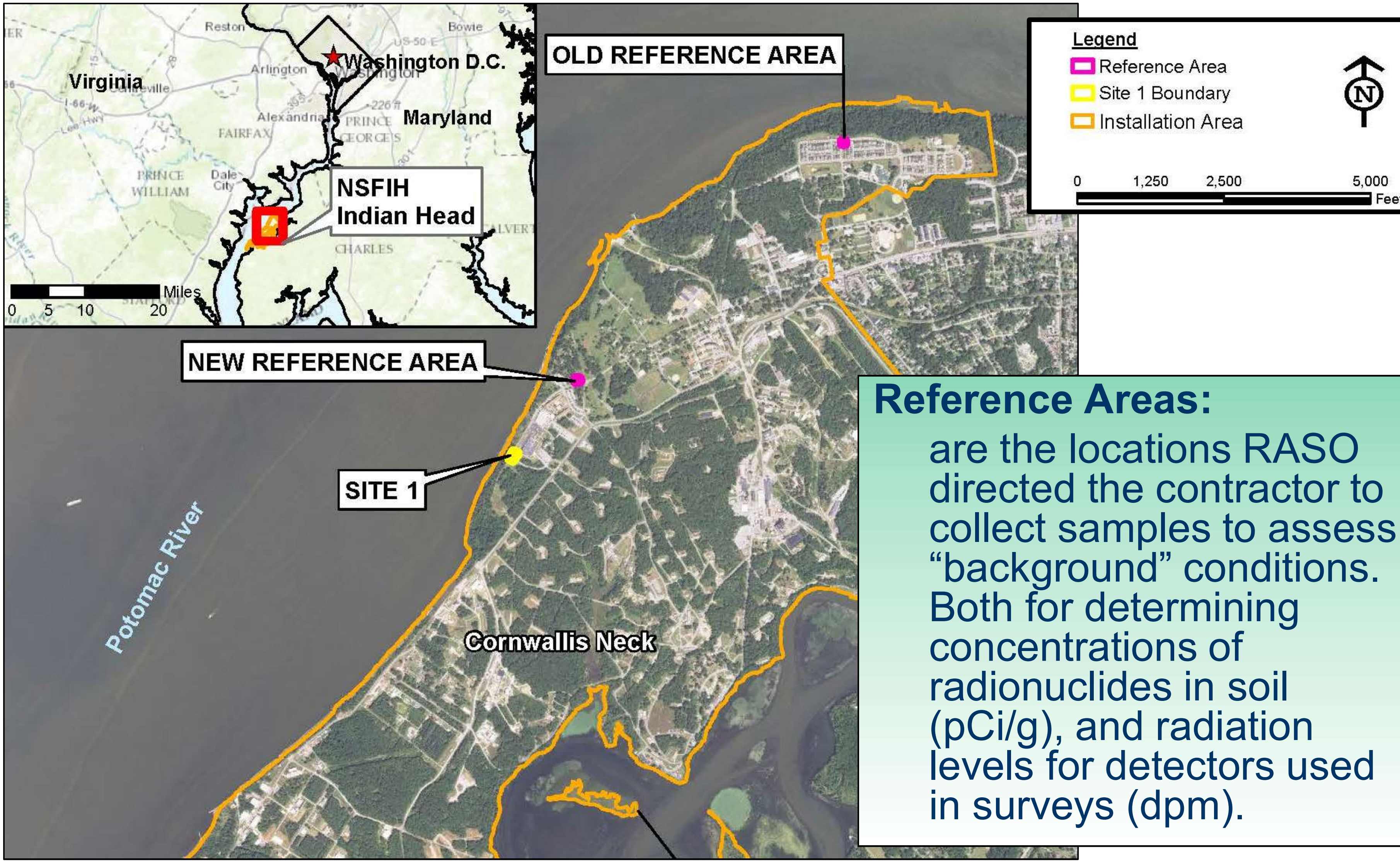
α particles: 2 protons and 2neutrons (aka, helium atom). Blocked by skin/paper/1-inch of air.

β particles: 1 electron. Approx. 6-10 ft effective travel distance. Can penetrate skin, but easily blocked by a metal sheet, thick plastic, or the human body.

γ rays: are photons emitted as the atom goes from a high energy state to a lower energy state. Easily passes through the human body, and is blocked by a foot of lead, 14-ft of water, 7-ft of concrete etc.

Ionizing radiation can break chemical bonds and damage DNA.

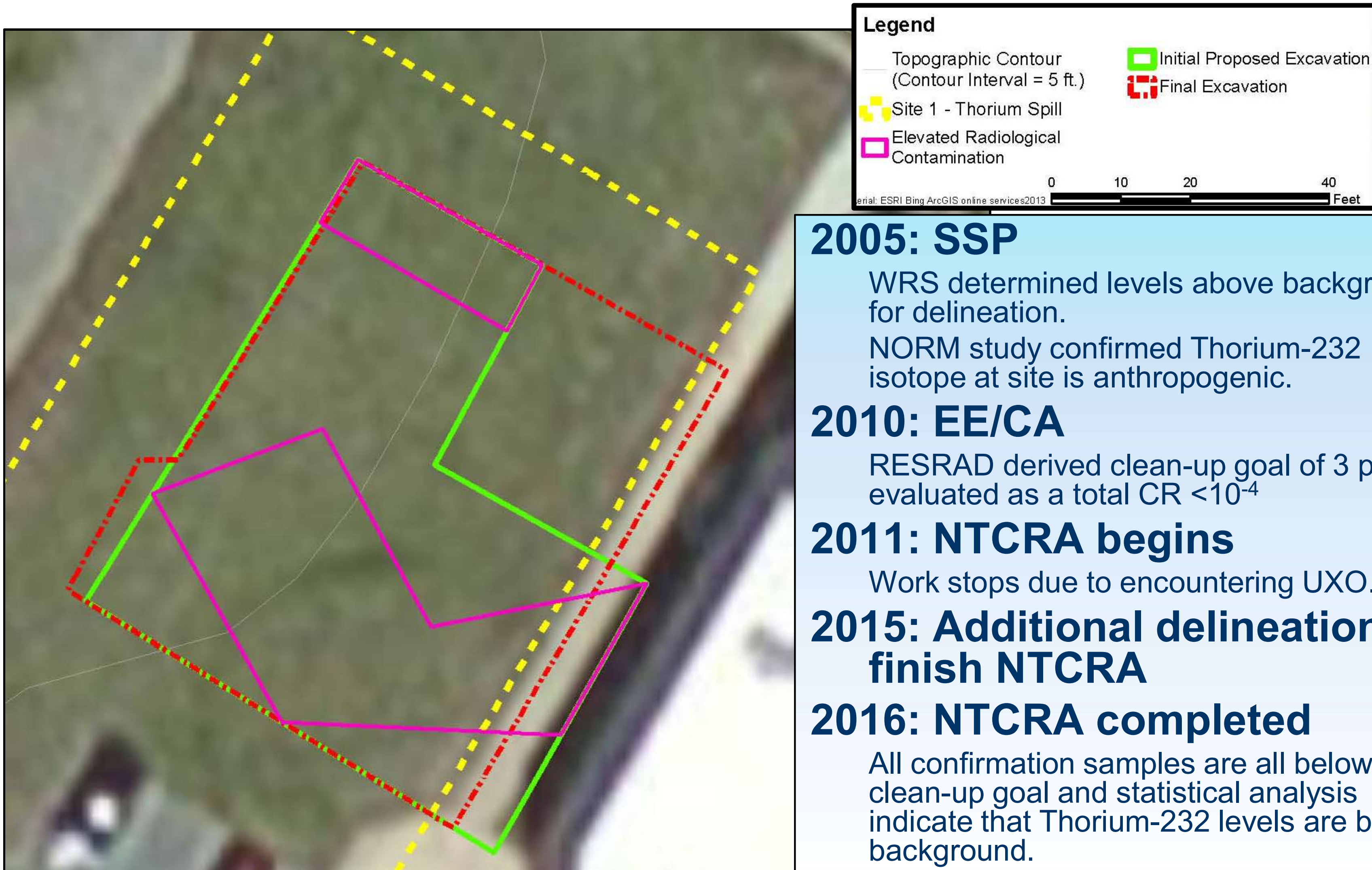
Site 1 Overview



Reference Areas:

are the locations RASO directed the contractor to collect samples to assess "background" conditions. Both for determining concentrations of radionuclides in soil (pCi/g), and radiation levels for detectors used in surveys (dpm).

Site 1 Removal Action Summary



2005: SSP

WRS determined levels above background for delineation.

NORM study confirmed Thorium-232 isotope at site is anthropogenic.

2010: EE/CA

RESRAD derived clean-up goal of 3 pCi/g, evaluated as a total CR <10^{-4}

2011: NTCRA begins

Work stops due to encountering UXO.

2015: Additional delineation to finish NTCRA

2016: NTCRA completed

All confirmation samples are all below the clean-up goal and statistical analysis indicate that Thorium-232 levels are below background.

Site 1 Removal Action Summary

NTCRA Results:

- No confirmation samples were above the EE/CA clean-up goal of 3 pCi/g.
- Based on the **RESRAD** calculated a DCGL with a maximum CR of 10^{-4} (i.e. model found a maximum risk of 9.50×10^{-5} at 10 years)
- Average background concentration: 1.15 pCi/g
- Average post-NTCRA confirmation result: 0.79 pCi/g
- All detector surveys/scans prior to backfill were at background levels.
- Costs of the NTCRA alone were around **$1.1M** to excavate and dispose of approximately **172 yd^3** of soil.

EPA :

- Eco-risk resolved based on the fact that residual levels are below background.
- UCL 95 to calculate the background and confirmation sample levels. Background is: 1.19 pCi/g ☺
  - Confirmation is: 0.935 pCi/g
- **PRG CR** risk for Confirmation is: 2.58 x 10-4, Background: 3.25×10^{-4}
- Residual risk remains above acceptable range (3×10^{-4} per 2014 Memo). ☹

Elevated Tier Negotiation with EPA:

- Via negotiation, we were able to reconcile the MARSSIM approach with site closure using the SSP process in our FFA, under CERCLA. We arrived to the agreement that our site was remediated to background levels.

Challenges and Considerations

- Guidance using MARSSIM surveys or EPA's RAGS (especially DQOs).
- Applicable Regs: NRC Release criteria (25 mRem/yr) vs. EPA's Acceptable Risk Range.
- Dose models and remediation goals, EPA's PRG vs. ANL's RESRAD.
- How to demonstrate background concentrations with NORM, WRS, or other accepted statistical methods. Is Radionuclide speciation necessary?
- How would clean soil covers, or paving mediate risk?
- LLRW removal actions are extremely expensive. This project cost approximately $6,000 per CY of soil disposed (and backfilled).

Knowledge Check

- **What unit measures the biological dose of ionizing radiation?**
  A) Gray
  B) Curie
  C) Sv
  D) dpm

- **True or False: A gamma walkover-survey that measures your radioactivity levels as equivalent or less-than background can be used to closeout a site?**

Knowledge Check (Answers)

- **What unit measures specific activity, which is the dose of ionizing radiation?**
  C) Sv (Or Sievert)

- **True or False: A gamma walkover-survey that measures your radioactivity levels as equivalent or less-than background can be used to closeout a site?**
  False: confirmatory sampling with sufficient laboratory quality control, to demonstrate radionuclide concentrations, typically measured in rad-emissions/unit-mass in pCi/g or Bq/g.

Take-Aways

- **Work with your Partnering Team to obtain concurrence to technical approaches.**
- **Agree on establishing a background level for clean up and representative reference areas. Do you know all your radionuclides present? NORM studies are recommended to determine radionuclide species. Is groundwater affected?**
- **Reconcile risk screening and assessment methods. E.g. does your approach using MARSSIM meet the technical guidelines in EPA RAGS? Stronger CSMs and quantitative methods will produce the most defensible results.**
- **Use applicable field survey to save costs on confirmatory samples and minimize removal volumes. Work with RASO (and other Navy SMEs) early in the process to provide technical expertise on your approaches.**

Contacts and Questions

Points of Contact
NAVFAC Washington: Alex Scott – alex.e.scott@navy.mil
Questions ?

Supplemental Information

Helpful Resources

- http://www.marssim.com/
- https://epa-prgs.ornl.gov/radionuclides
- https://www.epa.gov/superfund/radiation-superfund-sites
- https://www.nrc.gov/about-nrc/radiation/health-effects/radiation-basics.html
- http://www.navfac.navy.mil/go/erb (Navy Radiological Work Group & Informative White Papers)

MARSSIM and CERCLA (optional)

MARSSIM and CERCLA/RCRA (MARSSIM Appendix F)

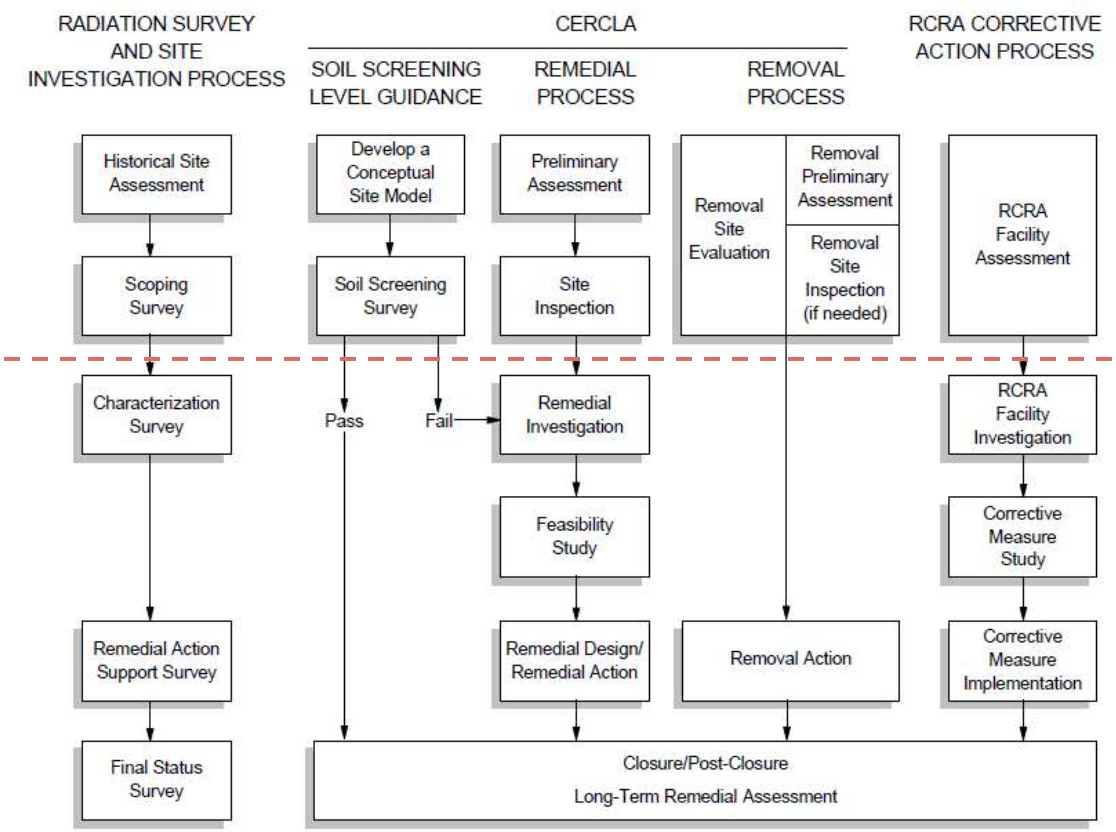


Figure F.1 Comparison of the Radiation Survey and Site Investigation Process with the CERCLA Superfund Process and the RCRA Corrective Action Process

Site 1 was to remain at the SSP/NTCRA Stage. The NTCRA was intended to remediate the site to closure.

However, disagreements with the protectiveness of the clean-up goal, and methods of site assessment and survey have prevented site closure so far…